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(Infinity 3.0-001 CIP)

INTERFACE CIRCUIT FOR UTILIZING A
FACSIMILE COUPLED TO A PC AS A SCANNER OR PRINTER

5 This application is a continuation-in-part
of Application Serial No. 08/226,278, filed April
11, 1994.

FIELD OF THE INVENTION

10 The present invention relates to
interfacing a facsimile with a PC and more
particularly to an interface circuit of highly
simplified design and including a novel ringing
circuit capable of generating a sine wave of a given
amplitude and frequency from a small, portable DC
battery or 9V DC power supply.

15 **BACKGROUND OF THE INVENTION**

20 As is well known in the art, a
conventional facsimile scans documents and transmits
the scanned information through a modem in a
standard facsimile format to a remote facsimile
which receives the transmitted data by a modem and
converts the transmitted data into a form for
printing a document which is a replica of the
document scanned by the transmitting facsimile.

25 Scanning and printing devices especially
adapted for use with PCs (i.e. personal computers)
are relatively expensive devices typically costing
many hundreds of dollars to as much as several
thousands of dollars for applications requiring
character recognition capabilities.

5 It has been recognized that conventional facsimile machines may be utilized as scanners or printers for PCs. However, the interface devices presently available are both complicated and expensive and typically require a microprocessor which further tends to increase both cost and circuit complexity.

OBJECT OF THE INVENTION

10 It is, therefore, a principal object of the present invention to provide a circuit for interfacing a PC and a facsimile to enable the facsimile to be utilized as a scanner or a printer for a PC and to accomplish all of the objectives of a scanner or a printer in a simple straightforward manner through the use of a circuit of highly simplified design and low cost.

BRIEF DESCRIPTION OF THE INVENTION

20 The present invention achieves all of the above as well as other objectives through apparatus which is characterized by comprising first switch means capable of selectively coupling a PC modem and a facsimile modem to independent telephone lines when in a non-scanning/printing mode and for decoupling the PC and facsimile modems from the telephone lines and coupling these modems to one another when placed in a scanning/printing mode.

25 Second manually operable switch means activates a novel ringing circuit which generates a sine wave of appropriate amplitude and frequency and applies this ringing circuit to the PC modem, when used as a scanner or to the facsimile when being

used as a printer, causing the PC or facsimile machine to respond to the simulated transmit request.

Release of the circuitry operating button causes the interface circuitry to apply an off-hook condition to the facsimile. Document scanning or printing is initiated by pressing the facsimile start button or the start button provided as part of the PC or by a program step integrated into the PC as part of a print mode (selecting the facsimile as the output device for printing). Transmitted data may be directly stored in a PC memory. Documents incorporating alphanumeric data may be converted by a software program incorporated into the PC.

The ring generating circuit responsive to pressing of the operating button generates a transmit request signal by converting the low voltage from a DC source into a 20 cycle sine wave of 90 volt amplitude through the employment of a pulse generating circuit coupled to phase delay means and applying phase delayed and undelayed pulses to a transistorized switching circuit for selectively applying positive DC voltage to opposing inputs of a step-up transformer which applies a boosted sinusoidal ring signal to the PC modem, the ring generating circuit generating a ringing signal of the appropriate amplitude and frequency in a highly simplified and inexpensive manner. Since operation of the ringing circuit is completed in less than two seconds, a battery, if used, will have an extremely long operating life. Alternatively, if a 9V DC power source is used the battery is not required at all.

The simple, straightforward operation of only three switches eliminates the need for

complicated, expensive and typically microprocessor-based circuitry.

BRIEF DESCRIPTION OF THE FIGURES

5 The above, as well as other objects of the present invention, will become apparent upon reading the accompanying description and drawings in which:

10 Fig. 1 is a circuit diagram of the interface circuitry of the present invention which enables a PC to utilize a conventional facsimile as a sophisticated scanner or printer.

15 Fig. 1a is a flow diagram of the circuitry of Fig. 1 employing the microprocessor-based tone detecting circuit of Fig. 1.

20 Figs. 2a-2i show simplified block diagrams of various system arrangements employing the circuitry of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

AND PREFERRED EMBODIMENTS THEREOF

25 Fig. 1 shows an interface circuit 10 embodying the principles of the present invention and being comprised of a switch assembly SW2 which is a four-pole double-throw switch having four movable switch arms SW2-2, SW2-5, SW2-8, and SW2-11, each cooperating with a pair of stationary contacts, as shown. For example, and for simplicity, note that switch arms SW2-2 is switchable between stationary contacts SW2-1 and SW2-3.

30 Movable switch arms SW2-2, SW2-5, SW2-8 and SW2-11 are all ganged to operate in unison as shown by common operating button B2 coupled to the switch arms through a linkage arm LA2 shown in

schematic fashion as a dotted line. The switch is designed so that the switch arms are retained in the positions to which they are moved.

5 The switch arms are arranged in pairs, switch arms SW2-2 and SW2-5 selectively coupling a modem of a PC (not shown for purposes of simplicity) to either a first telephone line #1 through jumper JP3 or directly to a local facsimile machine (not shown for purposes of simplicity) through a jumper 10 terminal JP2.

15 In a similar fashion, a pair of switch arms SW2-8 and SW2-11 selectively couple the local facsimile machine through jumper JP2 to either a separate telephone line #2 (through jumper JP4) or to the modem of the PC.

20 A double-pole single-throw switch SW3 is provided to couple either the local facsimile machine or the PC modem to a single telephone line or alternatively, disconnects the PC modem and facsimile machine from the common telephone line. For example, in applications where both the local facsimile and the PC each have an independent, 25 dedicated telephone line, switch SW3 remains open. In applications where only a single telephone line is provided, both PC and the local facsimile may share the single telephone line by gaining access thereto in a staggered manner.

30 Switch SW1 which is a three-pole, double-throw switch, comprises three movable switch arms SW1-1, SW1-4 and SW1-7, each movable switch arm cooperating with a pair of stationary switch arms.

35 Movable switch arm SW1-1 selectively couples the output terminal of the pair of secondary windings W2 of a step-up transformer TR1 either to stationary terminal SW1-2, which isolates the output

5 of the transformer TR1 from the operating circuitry, or stationary contact SW1-3 which couples the secondary winding W2 of transformer TR1 through movable switch arm SW1-7 and stationary contact SW1-9 simultaneously to stationary contacts SW2-6 and SW2-12 of four-pole double-throw switch SW2 for simultaneous connection to the PC modem and the local facsimile, when switch arms SW2-5 and SW2-11 respectively engage stationary contacts SW2-6 and SW2-12.

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15 Movable switch arm SW1-4 selectively couples a small nine volt (9V) DC source (through jumper J5) to either stationary switch arm SW1-5 for coupling nine volt (9V) DC to a current generator circuit 12 or alternatively coupling nine volt (9V) DC to stationary terminal SW1-6 which in turn provides DC power to the nine volt (9V) ring generator circuit arranged within the dotted region as shown.

20 Current generator circuit 12 is comprised of resistors R1, R2 and R5, transistors Q1 and Q6, diode D2 and LED-type diode D3 which are connected in the manner shown to provide a constant current which simulates an off-hook signal, utilized in the manner to be more fully described hereinbelow. Resistor R2 serves as a current limiting resistor. LED D3 lights to denote operation of the constant current generator.

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30 Ring generator circuit 14, which is utilized to generate a 20 Hz sine wave of a 90 volt amplitude, comprises a 555-type timing circuit 16 which, when activated by a nine volt DC input, applied to timer 16 through terminal VCC and resistor R13, provides a pulse train of equal width,

positive-going pulses at a pulse rate of approximately 20 Hz at its output 16a.

5 The pulse train generated by the 555 timer 16 is simultaneously applied to the input of inverter U1A whose output is simultaneously coupled to the base electrodes of transistors Q2 and Q4, through resistor R6 and through inverter U1B and resistor R9.

10 The pulse train, as was set forth hereinabove, is simultaneously coupled to the -T input of a one-shot multivibrator operating as a phase delay circuit and whose Q output is coupled to the input of inverter U1E. The Q output of one-shot multivibrator U2A provides a phase delayed pulse 15 which is coupled through the output of inverter U1E simultaneously to the base of transistor Q5 through resistor R8 and to the base of transistor Q3 through inverter U1F and resistor R7. Transistors Q2-Q5 and resistors R6-R9, together with resistor R10, form a 20 full bridge switching circuit which is powered by the nine volt (9V) DC source applied to the terminal VCC to provide drive current sufficient to drive transformer TR1, comprised of a pair of primary 25 windings W1 and a pair of secondary windings W2, to generate a sine wave output. The pair of primary windings W1 and secondary windings W2 are coupled in parallel and the windings are arranged to provide a step-up transformer to magnify the input voltage preferably by ten to one (10:1), generating the 30 desired output voltage which, in the present application, is a 20 Hz output of 90 volt amplitude with 15 mils of current from a nine volt (9V) DC, 150 mils current source. If desired, the frequency, amplitude and current of the circuit can be changed 35 by selecting different component values for the

5 passive elements. The component values chosen in the present invention have been selected to generate a signal which reproduces a standard bell ring signal employed in a conventional transmission between remote facsimile machines. The branch circuits BC1 and BC2 of the bridge circuit are alternately rendered conductive to alternately apply a positive voltage to opposing inputs of the input windings W1 for generating a sine wave from the 10 positive-going pulses produced by timer circuit 16. The two input windings W1 are coupled in parallel as are the output windings W2.

15 The bell ring signal is selectively supplied through movable switch arm SW1-1 of the three-pole, double-throw switch SW1 described hereinabove.

The operation of the interface circuit of the present invention is as follows:

20 Assuming that the local facsimile is desired to be operated in combination with the PC and to function as a scanner, the switch SW2 is moved from the normal position, in which the movable switch arms are shown in solid line fashion, to the dotted line position simultaneously disconnecting the PC modem and the local facsimile from the telephone lines and directly connecting the PC receive line, PCR1 to ground and the PC transmit line PCT1 directly to stationary contact SW1-9. The 25 local facsimile transmit line FXT2 is directly connected to ground and the facsimile receive line FXR2 is connected in common with line PCT1 to stationary contact SW1-9 of switch SW1. Switch SW3 may be either in the open or the closed position 30 when switch SW2 is moved to the scan mode.

Switch SW1 is operated by pressing button B1 which is ganged to the movable switch arms SW1-1, SW1-4 and SW1-7 by a common linkage arm represented schematically by dotted line LA1. A biasing member or spring SWP1 normally biases the movable switch arms to the solid line position shown in Figure. By depressing switch button B1, the switch arms SW1-1, SW1-4 and SW1-7 are simultaneously moved to the dotted line positions shown in Figure 1. Button B1 is maintained in the depressed position for a period preferably between one and two seconds. In the dotted line position, the nine volt (9V) DC source is coupled through switch arm SW1-4 and stationary terminal SW1-6 to the VCC terminals of ring generator circuit 14, producing a 20 Hz sine wave of 90 volt amplitude and a current of 15 mils at the secondary windings W2, which is applied to the PC line PCT1 through SW1-1, SW1-3, SW1-7, SW1-9, 126, SW2-6 and SW2-5, simulating what the PC believes is a request by a "remote" facsimile to transmit data thereto. The PC, which may be any type of computer (including but not limited to an Apple Macintosh, IBM PC, PCAT or PCXT) is provided with either an internal or external group III facsimile interface board, and shifts to a receive mode for receiving what appears to the PC to be a facsimile transmission from a "remote" facsimile machine.

30 After holding the button B1 depressed for a time which need not exceed approximately two seconds, button B1 is released causing the nine volt (9V) DC source to be coupled to input 12a of current generator circuit 12, which circuit applies the constant current to the facsimile receive line FXR2 to create what appears to the facsimile machine to 35 be an off-hook condition. Simultaneously therewith,

LED D3 lights indicating that the current generator circuit is presently in operation.

5 The local facsimile machine recognizes the constant current as representative of an off-hook condition preparing the local facsimile machine for transmission.

10 Thereafter, the conventional start button of the facsimile machine (not shown for purposes of simplicity) is pressed to start communication of the data scanned by the local facsimile machine from a document (or documents) placed within the facsimile machine document input (also not shown for purposes of simplicity).

15 The facsimile machine may be either a group I, group II, or group III machine, although optimum document resolution can be obtained through the use of a group III facsimile machine.

20 The conventional PC can store the transmitted data in its memory as a "picture" the resolution of the picture being 200 by 100 pixels for old facsimile machines, 200 by 200 pixels for standard facsimile machines and 400 by 400 pixels for new facsimile machines. Alternatively, a conventional OCR software package such as, for example, a CAERE OCR program available from Bitsoftware may be employed. Many alternative OCR software packages may be utilized to convert the "picture" transmitted by the facsimile machine to binary character form for word processing use or the like.

30 Operation of the facsimile machine in combination with the PC wherein the facsimile machine operates as a printer is as follows:

35 The ring generating circuit is not required to be operated in this mode and in

applications where a facsimile machine is interfaced with a PC for use only as a printer, the ring generating circuit and the cooperating spring bias switch may be eliminated.

5 Switch SW2 shown in Fig. 1 is moved from the solid line to the dotted line position decoupling the PC and facsimile machine from the telephone lines and coupling the PC and facsimile machine together.

10 Switch SW1 is operated to power the current generator circuit 12 causing both the PC and the facsimile machine to see an off-hook condition.

15 The computer (PC) is operated either by providing a switch such as a push button switch (not shown for purposes of simplicity) to enter into a standard protocol with the facsimile machine and thereafter to transmit information in standard facsimile machine format. The facsimile machine senses that it is communicating with a remote facsimile machine and creates a document in accordance with the data received from the PC in "pixel" form. The PC may be provided with a standard program having a print mode in which the facsimile machine is identified in the printing routine as the specific output device being utilized during such a print mode. Upon completion of printing mode, switch SW2 may be returned to the solid line position decoupling the PC from the facsimile machine and recoupling the PC and facsimile modems to their associated telephone lines.

30 Figs. 2a-2h show various arrangements in which the present invention may be utilized.

35 Noting, for example, Fig. 2a, the circuitry 10 of the present invention is coupled

between a standard facsimile machine 30, a PC-type computer 40 having a facsimile modem circuitry 41 and central office telephone lines 50 and 51. In the arrangement shown in Fig. 2a, the facsimile modem circuitry may be either internal or external to the PC-type computer 40.

Fig. 2b shows another alternative embodiment in which the circuitry of the present invention is incorporated into the PC-type computer and may be arranged on its own printed wiring board or on a printed wiring board which is common to the circuitry 10 of the present invention and the facsimile modem circuitry 41. The arrangement of Fig. 2b is otherwise the same as that shown in Fig. 2a. The circuit 10 shown in Fig. 2b is provided with three RJ-11 telephone cable connections for respective connection with the facsimile machine 30 and telephone lines 50 and 51. If only one additional telephone cable is provided, the standard facsimile machine 40 and the internal facsimile modem 41 may share that cable.

Fig. 2c shows another alternative arrangement in which the circuitry 10 of the present invention is integrated into the standard facsimile machine 30. The operation of the arrangement of Fig. 2c is otherwise similar to those shown in Figs. 2a and 2b.

Fig. 2d shows an arrangement in which the circuitry 10 of the present invention is mounted upon its own printed wiring board and is arranged within the PC-type computer 40 and is electrically connected to the internal facsimile modem 41 by an external RJ-11 cable as shown. The operation is otherwise the same as the embodiments of Figs. 2a-2c described hereinabove.

5 The circuitry 10 of the present invention may alternatively be placed upon a printed circuit card of approximately a credit card size for insertion in a bus slot provided in present-day PCs enabling the circuit on the printed circuit card, inserted into a slot provided along the exterior of the PC, to be coupled to a PCMCIA bus which is an additional bus that may be addressed by the PC.

10 Fig. 2e shows still another arrangement in which the PC-type computer 40 is coupled to external facsimile modem circuitry 41, for example, through an RS-232 cable. The facsimile machine interfaces to the external facsimile modem 41 through circuitry 10 by way of an RJ-11 telephone cable. When in the 15 normal mode of operation, circuitry 10 interfaces central office telephone lines 50 and 51 through the RJ-11 telephone cables, as shown. Cable 50 may be employed for standard facsimile machine telephone communications while telephone line 51 is used for the external facsimile modem circuitry. If only one 20 central office telephone line is available, line 50 may be shared in the manner previously described.

25 Fig. 2f shows an arrangement in which interface circuit 10 is internal to the facsimile machine. PC-type computer 40 is coupled to the facsimile modem circuitry 41 and interface circuit 10 through an RS-232 cable. When in the normal mode of operation, circuitry 10 interfaces the central office telephone lines 50 and 51 through RJ-11 30 telephone cables, as shown. Cable 50 may be employed for standard facsimile machine telephone communications while telephone line 51 is used for the external facsimile modem circuitry. If only one central office telephone line is available, line 50, 35 for example, may be shared in the manner previously

described. The arrangement of Fig. 2f is used with PC's which do not have a fax modem installed. When interface 10 is installed internal to the facsimile, the fax modem of the fax machine incorporates many of the functions of circuit 10, through integration of the already existing circuitry components of the fax modem.

The present invention may be employed with telephone systems having digital signal processing. Fig. 2h, which is similar to Fig. 2f, and which shows like circuits designated with like numerals, further includes an interface 60 for digital signal processing. The send and receive options required for scanning and printing are provided by interface 60, which may, for example, be a chip set such as PEB 2091 N-V4.4 and EPB 2186 N-V4.4, manufactured by Siemens. Any other chip set having similar operating characteristics may be employed. As other digital signal formats come into use, such as ADSL (Asymmetric Digital Subscriber Line) HDSL (High Bit Rate Digital Subscriber Line), or the like, a chip set for handling such formats may be substituted for interface 60.

As shown in Fig. 2i, a RAM and/or Fixed Disk 70 may be incorporated into the interface 10, integrated with a fax modem 30 to allow for the capture of images or documents for later transfer into the PC 40 or the facsimile machine 30, or for image enhancement within the interface configuration 10. The addition of the data storage feature is particularly desirable for the fax machine or fax modem when they are in normal fax send or receive modes.

5 Optionally, the data storage feature is desirable for field application usage where information may be downloaded from a PC and stored in interface 10 for later transfer to a facsimile machine or a PC. Storage would be retained in this instance by battery backup incorporated in the RAM memory 70. Battery backup is not necessary for fixed disk storage.

10 Fig. 2j shows an arrangement for automated scanning and printing functions between a fax modem and a fax machine.

15 As represented in Figs. 2a-2f, in order to activate an automated process for scanning or printing, the ring circuit 4 (Fig. 1) interfaces with the Tip and Ring features of the fax modem or fax machine. This is dependent on keying in a code on the fax keypad, such as ## or #* or any other predetermined code in order to respectively identify the scanning and printing functions. Interface 10 20 detects the tones generated by the inserted code (at the tone receiver 25 and generates a ring signal. The ring signal is detected and interpreted by the ring detect circuit of the fax modem or the fax machine. The fax modem or fax machine then generates receive signals or tones which indicate a connection. The fax modem or fax machine commences the scanning of the fax image or print cycle.

25 30 By depressing a predetermined code such as ## on the fax machine key pad, the tone detector circuit 25 interprets this code, enabling a control circuit to activate first (26) and second (27) relay means. Relay 26 disconnects the fax machine and the fax modem (connected to the PC) from the Central Office terminal lines. Relay 27, then connects 9V to the ring generator circuit 14 causing a

sinusoidal ring signal of a predetermined frequency and amplitude to be generated to the PC fax modem. The PC fax modem answers and starts the scanning process from the fax machine to the PC.

5 A communication program stored in the PC allows the code #* (for example) to be entered, generating the tone signal from the fax modem. The tone detector circuit in the interface 10 interprets this code, enabling a control circuit to activate first (26) and second (27) relay means. Relay 26 disconnects the fax machine and the fax modem (connected to the PC) from the Central Office terminal lines. Relay 27, then connects 9V to the ring generator circuit 14 causing a sinusoidal ring signal of a predetermined frequency and amplitude to be generated to the fax machine. The fax machine answers and starts the printing process from the PC fax modem.

20 The switch version does not require the ## or #* or any other code, but activates the automated scanning/printing by pressing the ringer button B2.

25 The provision of the scan and print functions internal to the facsimile machine may also be accomplished by utilizing the analog output of the optical scanning circuit 75 of the facsimile machine (Fig. 2g). The analog signals are processed by the control/modem circuitry 76 where they are converted into a digital serial signal and then transmitted through the RS 232 sending interconnect port, the signal is then received by an RS232 connector at the PC. The aforementioned procedure utilizes unused signal lines which are available on most modem chips such as the Rockwell chip series.

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5 A send and receive driver software package then implements the following action. The receive driver software accepts the digital image for storage or processing as appropriate. This send/receive driver communications software package also has the ability to send a digital image to the facsimile machine for printing purposes. The facsimile machine's control/modem circuitry ⁶ and then processed by the print driver ⁷ for printing.

10 This linkage method for scanning and printing utilizing a fax machine is particularly useful for a computer without a fax modem. Any available send/receive communications software package is acceptable.

15 The commands of ## or #* for sending and receiving are still appropriate for this application although any other desired commands may be selected.

20 For the automated operation, the circuitry 10 of Fig. 1 is provided with device 25 which includes an automatic tone detector circuit for receiving a unique number dialed by either the facsimile machine or the PC modem. Upon recognition of the unique number, as set forth above or by generation using other techniques, the tone receiver operates a driver circuit 26 for operating switch SW2 to decouple the PC and the facsimile machine from their associated telephone lines and for connecting the PC to the facsimile machine. Driver circuit 26 may be a relay or its equivalent for operating an armature (not shown) to move the switch arms between their two operating states. Driver unit 27 which likewise may be a relay or its equivalent, operates the switch SW1 to the position energizing the ringing circuit 14. A timer is set and when two seconds elapses, unit 27 is deenergized

causing the off-hook signal to be generated by current generator circuit 12 through the release of the operating button. When printing or scanning is complete, the tone receiver unit is reset. A simplified flow diagram of the aforementioned 5 operation is shown in Fig. 1a.

The circuitry of the present invention is highly simplified in design and provides effective communication between the PC and local facsimile machine enabling the local facsimile machine to provide the dual functions of operating independently for transmission or reception to remote facsimile machines as well as functioning as a scanner or printer with a local PC. The circuitry 10 of the present invention provides all the necessary signal conditions which lead the PC and local facsimile machine to believe that they are communicating with one another over a telephone line. The facsimile machine, although operating in its normal fashion, functions very effectively as a scanner or printer as and when needed and provides 15 a scanning or printing capability at a mere fraction of the cost of conventional scanners or printers. 20

Simple switching of SW2 returns the PC and 25 facsimile machine to normal use.

The novel ring circuit provides the required ring signal which is conventional in present-day facsimile transmission application through the employment of an inexpensive, low 30 voltage, DC battery or 9V power source and, through the operation of two switches incorporated in the novel interface circuitry of the present invention, followed by operation of the facsimile start switch, provides an interface circuit which is extremely 35 easy to use and which eliminates the need for more

complicated and expensive microprocessor-based devices.

A latitude of modification, change and substitution is intended in the foregoing disclosure, and in some instances, some features of the invention will be employed without a corresponding use of other features. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the spirit and scope of the invention herein described.

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